

WHAT IS CLAIMED IS:

1. An angle detection apparatus comprising a line type distance measuring device including a pair of lenses disposed on a same plane to be spaced from each other by a base line length, a line sensor spaced from the pair of lenses by a predetermined distance, disposed to extend in a direction of the base line length, and made of a line of plural detectors on which a planar body as a distance measurement object is imaged through the pair of lenses, and an arithmetic part for calculating distances to plural different positions on the measurement object in plural different distance measuring directions on a plane including the base line length and the line sensor on the basis of output from the line sensor,

wherein the angle detection apparatus comprises:

typical value calculation means for forming plural small groups including some of the positions spatially adjacent to each other from the plural positions and calculating a typical value of the distances calculated by the arithmetic part for each of the small groups; and

inclination angle calculation means for calculating, on the plane including the base line length and the line sensor, an inclination angle of the planar body with

respect to the same plane on the basis of the typical value.

2. The angle detection apparatus as recited in claim 1, wherein the typical value calculated by the typical value calculation means is an average value of the measurement distances in the small group.

3. The angle detection apparatus according to claim 1 or 2, wherein

the line sensor includes a first light receiving area in which one of a pair of images of the measurement object created by the pair of lenses is imaged, and a second light receiving area in which the other of the pair of images is imaged,

the first light receiving area includes plural distance measuring arithmetic areas respectively set to correspond to the plural different distance measuring directions,

the arithmetic part obtains the distances to the plural positions in the plural distance measuring directions by performing a distance measuring arithmetic operation on the basis of output from the distance measuring arithmetic areas in the first light receiving area and output from the second light receiving area,

the typical value calculation part further calculates a contrast centroid position of each of the

plural distance measuring arithmetic areas and obtains a centroid position typical value of a contrast distribution in the plural distance measuring arithmetic areas corresponding to each of the small groups, and

the inclination angle calculation part calculates, on the plane including the base line length and the line sensor, the inclination angle of the planar body of the measurement object with respect to the same plane on the basis of the typical value of the distances calculated by the typical value calculation part and the centroid position typical value of the contrast distribution.

4. The angle detection apparatus as recited in any one of claims 1 to 2, wherein

the arithmetic part further comprises a judgment part for judging, with respect to distance measuring results obtained by performing the distance measuring arithmetic operation of the distances to the plural different positions on the measurement object, existence of reliability of the distance measuring results of the distance measuring arithmetic operation on the basis of a correlation of the plural different positions in each of the small groups, and

the typical value calculation part calculates the typical value of the distance measurements from the

distance measuring results of the small group judged to have the reliability by the judgment part.

5. An angle detection apparatus comprising:

a distance measuring part for obtaining distances to plural measurement positions arranged on a straight line extending on a planar body as a measurement object;

a typical value calculation part for dividing the plural measurement positions into plural small groups spatially adjacent to each other and obtaining a typical value of the distances as distance measuring results by the distance measuring part in each of the small groups; and

an inclination angle calculation part for calculating an inclination angle between the distance measuring part and the measurement object on the basis of the typical value of the distances.

6. An angle detection apparatus comprising:

a line type distance measuring device including a pair of lenses disposed on a same plane to be spaced from each other by a base line length, a line sensor spaced from the pair of lenses by a predetermined distance, disposed to extend in a direction of the base line length, and made of a line of plural detectors on which a planar body as a distance measurement object is imaged through the pair of lenses, and an arithmetic part for

calculating distances to plural different positions on the measurement object in plural different distance measuring directions on a plane including the base line length and the line sensor on the basis of output from the line sensor;

a judgment part for judging existence of reliability of the distances as arithmetic operation results of the arithmetic part by forming a small group including the some positions from the plural positions and on the basis of a correlation of the arithmetic operation results in the small group; and

an inclination angle calculation part for calculating an inclination angle of the planar body with respect to the same plane on the plane including the base line length and the line sensor on the basis of the arithmetic operation results judged to have the reliability by the judgment part.

7. The angle detection apparatus according to claim 6, wherein the judgment part judges the existence of the reliability of the arithmetic results on the basis of whether the arithmetic results correspond to a desired straight line to be determined by the arithmetic results in the small group.

8. The angle detection apparatus according to claim 6, wherein the judgment part judges the existence of the

reliability of the arithmetic results on the basis of whether the arithmetic results are included in a desired reliability judgment area to be determined by the arithmetic results in the small group.

9. The angle detection apparatus according to claim 7 or 8, wherein the small group includes three positions adjacent to each other, and the judgment part judges whether the arithmetic result of the center position corresponds to or contained in the desired straight line or the reliability judgment area to be determined by the arithmetic results of two positions of both ends of the three positions.

10. The angle detection apparatus according to claim 7 or 8, wherein the line sensor includes a first light receiving area in which one of a pair of images of the measurement object created by the pair of lenses is imaged and a second light receiving area in which the other of the pair of images is imaged,

plural distance measuring arithmetic areas corresponding to the plural distance measuring directions are set in the first light receiving area, and

the arithmetic part performs a distance measuring arithmetic operation concerning the plural distance measuring directions on the basis of output from the distance measuring arithmetic areas in the first light

receiving area and output from the second light receiving area.

11. The angle detection apparatus according to claim 10, wherein the small group includes positions corresponding to three distance measuring directions adjacent to each other, and

the judgment part judges whether an arithmetic result of a position corresponding to the center distance measuring direction corresponds to a desired linear relation to be determined by two arithmetic results of the positions corresponding to the distance measuring directions of both ends in the three distance measuring directions.

12. An angle detection apparatus comprising:

a distance measuring part for obtaining distances to plural measurement positions arranged on a straight line extending on a planar body of a measurement object;

a judgment part for judging existence of reliability of the distances as distance measuring results of the distance measuring part by dividing the plural measurement positions into plural small groups and on the basis of a correlation of the distance measuring results in the small groups; and

an inclination angle calculation part for calculating an inclination angle between the distance

measuring part and the measurement object on the basis of the distance measuring results judged to have the reliability by the judgment part.

13. An angle detection apparatus comprising:

a line type distance measuring device including a pair of lenses disposed on a same plane to be spaced from each other by a base line length, a line sensor spaced from the pair of lenses by a predetermined distance, disposed to extend in a direction of the base line length, and made of a line of plural detectors on which a planar body as a distance measurement object is imaged through the pair of lenses, and an arithmetic part for calculating distances to plural different positions on the measurement object in plural different distance measuring directions on a plane including the base line length and the line sensor on the basis of output from the line sensor; and

an inclination angle calculation part for using at least two arithmetic results of the distances calculated by the arithmetic part to approximate a straight line expressing a correlation of the arithmetic results, obtaining an inclination of the approximated straight line, and calculating an inclination angle of the planar body with respect to the same plane on the plane



including the base line length and the line sensor on the basis of the inclination.

14. The angle detection apparatus as recited in claim 13, wherein the arithmetic part calculates, as the distances, lengths of plural vertical lines drawn from the plural different positions on the measurement object in the plural different distance measuring directions onto a first straight line extended from the base line, and

the inclination angle calculation part further includes a coordinate position calculation part to determine plural coordinate positions on the first straight line corresponding to the plural different positions, respectively, approximates a straight line expressing a correlation among plural positions determined from pairs of the determined coordinate positions and the calculated distances corresponding to those, and calculates the inclination angle from the inclination of the straight line.

15. The angle detection apparatus as recited in claim 14, wherein the approximation of the straight line expressing the correlation is based on a least square method.

16. An angle detection apparatus comprising:

a line type distance measuring device including a pair of lenses disposed on a same plane to be spaced from each other by a base line length, a line sensor spaced from the pair of lenses by a predetermined distance, disposed to extend in a direction of the base line length, and made of a line of plural detectors on which a planar body as a distance measurement object is imaged through the pair of lenses, and an arithmetic part for calculating distances to plural different positions on the measurement object in plural different distance measuring directions on a plane including the base line length and the line sensor on the basis of output from the line sensor;

a typical value calculation part for obtaining typical values of positions of plural small groups including some of the plural different positions on the measurement object, respectively, from the calculated distances; and

an inclination angle calculation part for using the plural typical values obtained from the typical value calculation part to approximate a straight line expressing a correlation of the typical values, obtaining an inclination of the approximated straight line, and calculating an inclination angle of the planar body with respect to the same plane on the plane including the base

line length and the line sensor on the basis of the inclination.

17. The angle detection apparatus as recited in claim 16, wherein

the arithmetic part calculates, as the distances, lengths of plural vertical lines drawn from the plural different positions on the measurement object in the plural different distance measuring directions onto a first straight line extended from the base line length,

the typical value calculation part obtains distances to the typical values of the positions of the plural small groups including some of the plural different positions on the measurement object, respectively, from the calculated distances, and

the inclination angle calculation part further includes a coordinate position calculation part for determining coordinate positions on the first straight line corresponding to the typical values of the positions, approximates the straight line expressing the correlation among the plural typical values decided from pairs of the determined coordinate positions and the distances to the typical values of the positions corresponding to those, and calculates the inclination angle from the inclination of the straight line.

18. The angle detection apparatus as recited in claim 17, wherein the approximation of the straight line expressing the correlation is performed by a least square method.

19. The angle detection apparatus as recited in any one of claims 16 to 18, wherein the typical value calculation part prepares the plural small groups, each including a predetermined number of the positions adjacent to each other from the plural different positions on the measurement object, by shifting the positions included in the small group one by one, and obtains the distances to the typical values of the positions for the respective small groups from distances to the positions included in the respective small groups.

20. An angle detection apparatus comprising:

a distance measuring device for measuring distances to plural mutually different measurement points arranged substantially linearly on a measurement object of a planar body; and

an inclination angle calculation part for approximating a straight line expressing a correlation between at least two measured distances, obtaining an inclination of the approximated straight line, and calculating an inclination angle of the measurement object with respect to the distance measuring device.

21. An angle detection apparatus comprising:

a distance measuring device for measuring distances to plural mutually different measurement points arranged substantially linearly on a measurement object of a planar body;

a typical distance value determination part for obtaining at least two typical distance measuring values on the basis of the plural measured distances; and

an inclination angle calculation part for approximating a straight line expressing a correlation between the at least two typical distance measuring values, obtaining an inclination of the approximated straight line, and calculating an inclination angle of the measurement object with respect to the distance measuring device on the basis of the inclination.

22. The angle detection apparatus according to claim 21, wherein the measurement object is a screen on which an image is projected.

23. A projector for projecting an image on a screen, wherein the projector comprises an angle detection apparatus as recited in claim 22, and an image distortion correction part for correcting a distortion of the image on the screen on the basis of an inclination angle calculated by the angle detection apparatus.

24. An angle detection method comprising:

a distance measuring steps of obtaining distances to plural measurement positions arranged on a straight line extending on a planar body of a measurement object;

typical value calculation steps of forming plural small groups including some of the positions spatially adjacent to each other from the plural positions and calculating a typical value of the distances obtained by the distance measuring steps for each of the small groups; and

inclination angle calculation steps of calculating an inclination angle of the planar body on the basis of the typical value.